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AUTHOR(S) – S.L. Penn
M.A. Robinson

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ABSTRACT

The personal maintenance activities on a multi-disciplinary earth orbital space station are scheduled and described. Operating modes based on the manpower available for work after the personal maintenance activities are accounted for are defined for nominal and off-nominal cases. The effects of crew illness and of excess work requirements are analyzed. The needs for exercise, hygienic measures, rest and recreation, etc., are discussed and the possible impact of uncertainties in these areas is pointed out.

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SUBJECT: Personal Maintenance Subsequence for a Multi-Disciplinary Earth Orbital Space Station - Case 720

DATE: December 27, 1968

FROM: S.L. Penn
M.A. Robinson

TECHNICAL MEMORANDUM

INTRODUCTION

This paper is part of a larger study of operations related to a large, multi-disciplinary space station[1,2]. The Personal Maintenance Subsequence covers those activities that are performed in order to insure the health and operational readiness of the astronauts and includes a schedule which allows the concurrent performance of necessary tasks. In the prototype mission, the desirability for round-the-clock experiment support suggests the establishment of a three shift day, with two men asleep and four awake at all times. The operating modes of the subsequence are defined by the number of men available for work at any one time. The nominal modes, which are repeated on successive shifts, fall into three main categories: two men available, four men available, and no men available. Figure 1 depicts a typical personal maintenance schedule. Off-nominal modes are determined by contingencies; illness or deconditioning making fewer men available for work, and emergencies requiring an increase in the available manpower (reducing the number in personal maintenance). Figure 2 characterizes the nominal and principal off-nominal modes and shows how and when transitions between them are effected.

The personal maintenance activities of the astronauts include eating, sleeping, hygiene, exercise, rest and recreation (R&R) and housekeeping. Whereas they are generally analogous to those performed on Earth, the special conditions of the space environment affect these activities in many ways. Several of these conditions and their consequences for personal maintenance are given below:

THE SPACE STATION AS A CLOSED ECOLOGICAL SYSTEM

Two main problems arise from this fact, namely, the possible adverse change in the microbiological balance, and the build-up of surface and atmospheric contaminants[3,4]. The first of these problems may affect personal hygiene by requiring more elaborate cleaning procedures, including the use of disinfectants. The second problem may require more elaborate housekeeping, including the wiping of interior surfaces of the spacecraft and equipment with cleansing materials.

THE EFFECTS OF CONFINEMENT

The effects of confinement have been studied extensively, and some tentative conclusions have been reached[5,6]. One of these conclusions is that the time spent in certain activities, such as eating, reading, and watching television, is generally greater than in non-confined situations, apparently to help consume excessive off-duty time. However, while a certain amount of rest and recreation is required, the main concern of men in confinement is to be kept usefully employed. We have assumed two hours per day as sufficient for rest and recreation, and shown an option for R&R by a two hour "Work or R&R" period on Figure 1. Actually, one would expect sufficient time for such activities to occur in conjunction with meal, hygiene, exercise, sleep, and uncommitted work periods. For example, exercise should not be sheer drudgery and should help serve the recreation function. Also, an eight hour sleep period is probably much more than the astronauts would need[5], and watching TV for an hour or so before retiring would help meet the R&R requirement. By means such as these the formally shown Work or R&R period could really be available for work, as is generally intended. Only when the mission activities have been so intense as to not permit sufficient R&R during the rest of the day would R&R assume sufficient priority to begin to preempt work activities.

While the subject of time off is not explored at length here, it seems reasonable to provide one day off per week, as planned for AAP, during which non essential work could be suspended and the men would have additional time for mission evaluation, R&R, or whatever other activities would provide as large a change from the daily routine as possible. In any case, it might be useful (though perhaps, inconvenient) to keep a record or log of off duty time, to facilitate concurrent or post flight performance analysis and to provide some assurance that the men are not overworking themselves. This option should be left open.

Of course, if the requirements for eating (including food preparation), for hygiene, and for housekeeping should prove to be more than anticipated and allowed for, some compromise of the work time and R&R time might have to be effected. However, if no serious problems in these regimes are encountered in the preceding one to two month AAP flights, which will have been conducted by then, some confidence may be had in their not occurring on longer flights.

WEIGHTLESSNESS AND ITS PHYSIOLOGICAL EFFECTS

Both ground-based simulations and spaceflight experience have indicated that weightlessness will cause serious cardiovascular deconditioning unless appropriate countermeasures are

employed. One of these countermeasures is to induce artificial gravity, by an onboard centrifuge or by rotating the space station. The present study does not assume the existence of artificial gravity, but relies upon an exercise regime to counteract the effects of weightlessness*(7). While we may have underestimated the time requirements for this exercise regime (two 1/2 hour periods/man/day), it should be pointed out that exercise will also be a part of the medical experiments, and additional exercise can be performed during uncommitted worktime, if necessary.

Keeping these special conditions of space flight, i.e., the closed ecological system, confinement, and weightlessness, in mind, we now proceed to a formal description of the "modes" of activity in the Personal Maintenance Subsequence and then to a more detailed discussion of the activities themselves.

DESCRIPTION OF MODES

Nine modes have been identified for the Personal Maintenance Subsequence, three nominal (scheduled) modes and six off-nominal (contingency) ones. As pointed out earlier, the modes are distinguished primarily by the number of astronauts available for work. The assumption that men should be available on a 24 hour basis resulted in the schedule of Figure 1, where the three nominal modes recur in the same order and durations on each of three shifts and the crew operates essentially in pairs, with a different pair asleep in each shift. Four of the off-nominal modes are based upon astronaut illness or deconditioning and the possible requirements for an attendant. The last two correspond to contingencies when more men than are ordinarily available are needed for work. Figure 2 describes these modes in terms of certain properties: temporal factors, crew commitment, activities and performing agents, information generation and flow, power and special resource requirements, and transition factors (schedule or other causes for changing from one mode to another). The modes are summarized below:

Nominal Modes

A. Average Personal Maintenance: Two pairs of astronauts are engaged in personal maintenance activities (one pair is asleep). Thus, only one pair of astronauts is available for work. (2 hours/8 hour shift)

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*This is an important hypothesis, which will be tested in part in AAP and should be further pursued operationally or experimentally on subsequent zero-G space stations. Except for the rotating station, time for operational countermeasures to weightlessness must be allowed. Even in the rotating case, time for exercise must be allotted to maintain the crew's general physical condition.

B. Minimum Personal Maintenance: One of the three pairs is engaged in personal maintenance activities (sleep), thus making two pairs available for work. (4 hours/8 hour shift)

C. Maximum Personal Maintenance: All astronauts are engaged in personal maintenance activities (one pair asleep). Thus, none are available for work. (2 hours/ 8 hour shift).

Off-Nominal Modes

D. One Astronaut Sick*, Modified Average Personal Maintenance: This mode would replace Mode A when an astronaut who would ordinarily be available for work in Mode A becomes unavailable due to illness or deconditioning. Now only one man, instead of two, would be available for work.

E. One Astronaut Sick, Modified Minimum Personal Maintenance: This mode would replace Mode B should an astronaut become unavailable at that time. Now only three crew men would be available for work.

F. One Astronaut Sick, One Attendant; Modified Average Personal Maintenance: Should an otherwise available astronaut be so afflicted as to require attendance when Mode A would ordinarily be in progress, this mode would replace A and the astronaut's co-scheduled crew mate would attend him. None, instead of the usual two, would be available for work.

G. One Astronaut Sick, One Attendant ; Modified Minimum Personal Maintenance: This mode would replace Mode B if a sick man were to require attendance at that time. Only two of the usual four men would be available for work.

H. Reduced Personal Maintenance: There may be times in the life of the station when contingencies in other activities will require more manpower than is scheduled

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*The effect that a sick man has on the mission is treated later under "Contingency Considerations."

to be available.* In such a case one or more astronauts, as necessary, would have to leave their personal maintenance activities, thus impacting whichever of the modes they were in. Rest and recreation could be cancelled, eating and hygiene delayed, and other interrupted personal maintenance activities treated in accordance with their requirements. (This mode is really a condensation of several possible alternatives to the nominal modes, depending on which mode was in progress and how many additional men were needed.)

I. No Personal Maintenance: In this mode, in addition to other schedule modifications, the two sleeping astronauts are awakened. Six men become available for work for the duration of the contingency, which could be of a serious nature such as a fire, meteor puncture, or Environmental Control System failure.

DESCRIPTION OF ACTIVITIES

In order to give a clearer picture of the nature of the personal maintenance activities in the station, and to support the time assignments shown in Figures 1 and 2, brief descriptions of each activity, with amplifying information are given below:

A. Eating

Both food preparation and food ingestion are problems under conditions of weightlessness. We expect most food to be carried aloft in freeze-dried powder or tablet form, which must be reconstituted by the addition of water, either hot or cold. In calculating the time required for eating, the preparation time for the food must be included. Furthermore, ingestion of the food must be such that particles are not allowed to escape into the space station atmosphere, which means either sucking or squeezing the food into the mouth directly from the vessel in which it was prepared. All this must be followed by a careful cleanup procedure. Accordingly, we have allocated 2-1/2 hours per day for eating, consisting of 3/4 hour for breakfast, 3/4 hour for lunch, and one hour for dinner.

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*Usually, one man is kept unassigned to tasks requiring continuity of effort and can readily cease whatever he is doing to handle anticipated contingencies, such as repair work of the component replacement type. Those problems which for lack of a special skill can't be handled by the available man can usually be postponed until someone with the necessary skill becomes available. A case where these alternatives are not possible is the occurrence of a major flare during a Maximum Personal Maintenance mode, which could happen about once a month.[2] This would require the services of two men who would not otherwise be available.

B. Sleeping

We have allowed a full 8 hours per day for sleeping. This includes the time required to attach biomedical sensors for physiological monitoring during sleep, and for calibrating the EEG and EKG apparatus, if necessary. We expect that when the schedule of station operations is established, the astronauts will be able to sleep "on command." However, initially, we anticipate difficulties in sleeping at the required time, either as the result of the shifting of the diurnal cycles or as a result of noise and activity on the part of the other astronauts. The time allocated to sleeping thus allows for a transitional period between work and sleep, during which a sleeping pill, if necessary, can take effect. If eight hours sleep is not necessary (and the need can vary from one astronaut to another), then the extra time can be used for rest and recreation activities, as suggested earlier.

C. Hygiene

Of all the areas of personal maintenance, the one in which the greatest uncertainty exists is that of personal hygiene. The reason for this is that there are a large number of unanswered questions about both the possible changes in the microbiological balance and the buildup of contaminants. We can therefore assume that personal hygiene will include procedures for obtaining bacterial counts by wiping portions of the body with sterile swabs and storing them for later biochemical analysis. Depending upon the buildup of bacteria, the hygienic procedures may have to altered. We have allocated 1.75 hours for hygiene, broken up into two 1/2 hour periods and one 1/4 hour period, with the understanding that this time may have to be increased as a result of microbiological assessments.

D. Housekeeping

As noted above, there may be a buildup of contaminants within the space station. These may be either in the form of atmospheric contaminants, which may be removed by appropriate filtering of the atmosphere, or they may be in the form of particulate matter that adheres to the walls and equipment, as was found in the Gemini program[8]. We have allocated two short periods in each day per astronaut (1/2 and 1/4 hour respectively) for cleaning the space station in general, apart from the housekeeping that is associated with the activities of eating, sleeping and personal hygiene.

E. Exercise

As noted earlier, we are assuming that exercise will constitute the major countermeasure to cardiovascular deconditioning which might be expected in a weightless environment.

Accordingly, we have scheduled two half-hour periods per man per day for vigorous exercise, assuming that the problems of locomotion in the normal work period will also serve as an additional form of physical exertion. Again, the requirement for exercise cannot be stated in advance. It will have to be determined on the basis of physiological analysis of the individual astronauts, including dynamic analysis during the exercise conducted as part of the medical program.

F. Rest and Recreation

Studies of groups living and working under confinement have brought out the necessity for a period of time each day during which individuals are allowed to engage in unscheduled activities, either personal (reading, writing, etc.) or social (playing games, watching TV, etc.). We have shown, for each man in Figure 1, a two-hour period called "Work or Rest and Recreation." The intent, as pointed out earlier, is to use this time for scheduled work as necessary, contingent on meeting the R&R needs at other times during the day and on the "day off." Failing this, the assignment of the indicated two hours to R&R would take on increasing importance.

CONTINGENCY CONSIDERATIONS

As noted in the discussion regarding the nine modes of personal maintenance, the six modes referred to as "off-nominal" are contingency-related situations. The basic personal maintenance associated contingency is one of illness on the part of one of the astronauts, which may or may not require another crew member to act as an attendant. For the sake of simplicity, we carried out the analysis for only one ill crew member out of the possible six astronauts aboard, which resulted in the definition of modes D, E, F, and G. In more detailed planning ,the case of two or more incapacitated crew members should also be considered. (In addition to preplanning, this case would almost certainly require specific, real time consideration by the Mission Director).

In assigning an attendant for a sick astronaut, we picked his similarly scheduled crew mate. To make this a full time assignment for prolonged disabilities might be unrealistic, since each astronaut aboard the space station is most likely to be a specialist in some area, be it the operation of the station or the conduct of certain experiments. To assign the crew mate to full-time duties as a medical attendant is to deprive the station of his special knowledge and skills and, secondly , to place an undue responsibility on him for the care of another astronaut. A more likely procedure to follow, should the attendance requirements be that demanding ,is to rotate the assignment among several astronauts, since the sick

astronaut is under less constraint with regard to his sleep schedule and activities for which he may need assistance than are the others. It should be noted that when a sick man would ordinarily be in a personal maintenance mode, the work availability of other astronauts would not be altered. The sick man's crew mate who is also in a personal maintenance mode would be available to help the sick man, if necessary.

The absence of one man from work availability for short periods of time (say, up to a few days) would not necessarily impact the mission. A well-planned mission should leave one of the available-for-work astronauts uncommitted to tasks requiring continuity or regularity of performance, so that room exists for the handling of occasional higher workloads, minor crew disabilities, and other contingencies(2). However, when the workload due to contingencies becomes too high for handling within the regular available manpower or cannot be postponed to a more favorable time, then personal maintenance activities would be curtailed. This would increase the number of men available for work, by effecting transitions to mode H or I, as indicated earlier.

SUMMARY

In this memorandum we have sought to present a picture of the day-to-day activities and scheduling considerations in the area of personal maintenance. We have stressed some of the uncertainties of long duration space flights, such as the danger of microbiological and contaminating agents, and their possible impact on the mission. In addition, we have considered the impact on the schedule of contingencies involving the illness of one astronaut with and without the requirement for an attendant, as well as the reduction of personal maintenance activities to accommodate increased work requirements.

S. L. Penn

M. A. Robinson

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Attachment
Figures 1 and 2

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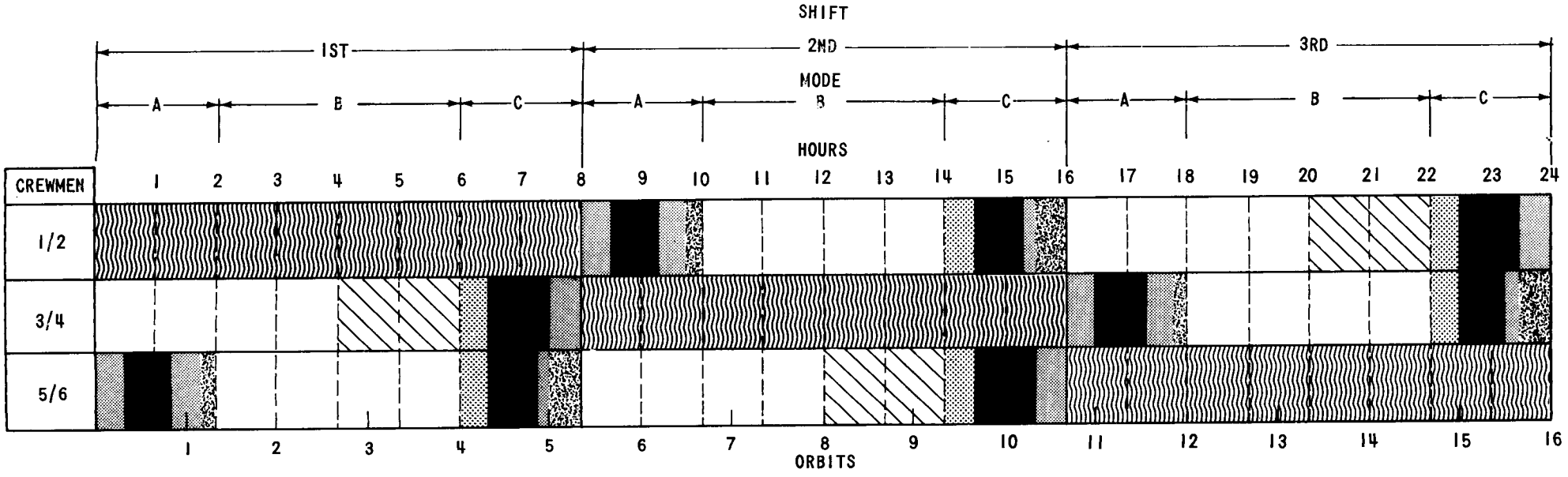

TYPICAL TIMELINE

SLEEP	8 HRS.
HYGIENE	1/2 HRS.
EAT	3/4 HRS.
HYGIENE	1/2 HRS.
HOUSEKEEP	1/4 HRS.
WORK	4 HRS.
EXERCISE	1/2 HRS.
EAT	3/4 HRS.
HYGIENE	1/4 HRS.
HOUSEKEEP	1/2 HRS.
WORK	4 HRS.
REST & RECR.	2 HRS.
EXERCISE	1/2 HRS.
EAT	1 HRS.
HYGIENE	1/2 HRS.
TOTAL	24 HRS.

MODE EXPLANATION

A AVERAGE PERSONAL MAINTENANCE
4 MEN IN P.M.; 2 AVAILABLE FOR WORK

B MINIMUM PERSONAL MAINTENANCE
2 MEN IN P.M.; 4 GENERALLY AVAILABLE FOR WORK

C MAXIMUM PERSONAL MAINTENANCE
6 MEN IN P.M.; NONE AVAILABLE FOR ROUTINE WORK

LEGEND

SLEEP
HYGIENE
EAT
HOUSEKEEP
WORK
EXERCISE
WORK OR REST & RECR.

FIGURE 1 - CREW IN-FLIGHT PERSONAL MAINTENANCE SCHEDULE

NOMINAL — OFF NOMINAL

PROPERTIES \ MODES	A AVERAGE PERSONAL MAINT. (P. M.)	B MINIMUM P. M.	C MAXIMUM P. M.	D 1 SICK, MODIFIED AVERAGE P. M.	E 1 SICK, MODIFIED MINIMUM P. M.	F 1 SICK, 1 ATTENDANT, MODIFIED AVG. P. M.	G 1 SICK, 1 ATTENDANT, MODIFIED MIN. P. M.	H REDUCED P. M. (MODIFIED A, B, ... G)	I NO P. M.
I. TIME: a) DURATION, REPETITIONS, USE OF CREW b) CONSTRAINTS	a) 2 HRS, 3 TIMES/DAY FOR 6 HRS/DAY TOTAL; 4 MEN AT A TIME b) GENERALLY, SCHEDULED ROUTINE WORK SHOULD REQUIRE NO MORE THAN 1 OF THE 2 MEN AVAILABLE OUTSIDE THIS MODE	a) 4 HRS, 3 TIMES/DAY FOR 12 HRS/DAY TOTAL; 2 MEN AT A TIME b) GENERALLY, SCHEDULED ROUTINE WORK SHOULD REQUIRE NO MORE THAN 3 OF THE 4 MEN AVAILABLE.	a) 2 HRS, 3 TIMES/DAY FOR 6 HRS HRS/DAY TOTAL; 6 MEN AT A TIME b) ROUTINE WORK SHOULD NOT BE SCHEDULED FOR THIS PERIOD.	a) ≤ 2 HRS, ≤ 3 TIMES/DAY FOR ≤ 6 HRS/DAY TOTAL; 5 MEN AT AT A TIME (1 SICK) b) WHERE POSSIBLE, WORK LOAD SHOULD BE KEPT AT OR WITHIN 1 MAN LEVEL.	a) ≤ 4 HRS, ≤ 3 TIMES/DAY FOR ≤ 12 HRS/DAY TOTAL; 3 MEN AT A TIME (1 SICK) b) WHERE POSSIBLE, WORK LOAD SHOULD BE KEPT AT OR WITHIN 3 MAN LEVEL	a) SAME AS FOR D, EXCEPT 6 MEN AT A TIME (1 SICK, 1 ATTENDANT) b) ROUTINE WORK MUST BE POSTPONED OR CANCELLED TO STAY IN THIS MODE.	a) SAME AS FOR E, EXCEPT 4 MEN AT A TIME (1 SICK, 1 ATTENDANT) b) ROUTINE WORK MUST NOT EXCEED 2 MAN LEVEL TO STAY IN THIS MODE	a) SEVERAL MINUTES TO SEVERAL HOURS, ~ ONCE/MONTH; 1-5 MEN AT A TIME b) ASSIGN MOST AVAILABLE AWAKE MEN FIRST, SLEEPING MAN LAST. DO NOT WAKE BOTH SLEEPERS AT SAME TIME.	a) TILL PROBLEM IS SOLVED OR ABORT EFFECTIVE; NO MEN IN P. M. b) WHOLE CREW AWAKE. AFTER RETURN TO NORMALCY, ALLOW MAX. R & R FOR AFFECTED MEN FOR ~ 1 DAY
II. ACTIONS & FUNCTIONS: AGENTS: CREW INTEGRATED MEDICAL & BEHAVIORAL LABORATORY MEASUREMENTS SYSTEM (IMBLMS) MISSION CONTROL CENTER (MCC)	CREW-2 ASLEEP & 2 IN HYGIENE, EATING, & HOUSEKEEPING (2 NOT IN P. M. ARE AT WORK OR AVAILABLE FOR WORK) IMBLMS-MONITORS &/OR TAKES OPERATIONAL MEDICAL DATA ON SLEEPING MEN, ~ 1 MIN. DURATION FOR ~ 3 - 4 TIMES PER HOUR PER MAN MCC-OCCASIONALLY REVIEWS MEDICAL DATA.	CREW-2 ASLEEP (OTHERS ARE AT WORK OR AVAILABLE FOR WORK, INCLUDING MEN IN REST & RECREATION) IMBLMS-SAME AS FOR A MCC-SAME AS FOR A	CREW-2 ASLEEP & 4 IN EXERCISE, EATING, HYGIENE, & HOUSEKEEPING. (NONE AVAILABLE FOR ROUTINE WORK) IMBLMS-SAME AS FOR A MCC-SAME AS FOR A	CREW-HEALTHY MEN SAME AS FOR A (ONLY 1 AVAILABLE FOR WORK) SICK MAN-(SEE TEXT FOR DISCUSSION) IMBLMS-SAME AS FOR A MCC - SAME AS FOR A. ALSO, MAINTAINS LIAISON BETWEEN CREW & GROUND M. D. FOR SICK MAN SUPPORT	CREW-HEALTHY MEN SAME AS FOR B (ONLY 3 AVAILABLE FOR WORK) SICK MAN-(SEE TEXT FOR DISCUSSION) IMBLMS-SAME AS FOR D MCC-SAME AS FOR D	CREW-HEALTHY MEN (EXCEPT ATTENDANT) SAME AS FOR A (NONE AVAILABLE FOR WORK) SICK MAN & ATTENDANT-(SEE TEXT FOR DISCUSSION) IMBLMS-SAME AS FOR D, AND ALSO ASSISTS IN MEDICAL ASSESSMENT MEASUREMENTS. MCC-SAME AS FOR D	CREW-HEALTHY MEN (EXCEPT ATTENDANT) SAME AS FOR B (ONLY 2 AVAILABLE FOR WORK) SICK MAN & ATTENDANT-(SEE TEXT FOR DISCUSSION) IMBLMS-SAME AS FOR F MCC-SAME AS FOR D	CREW-1 OR 2 ASLEEP. AT LEAST 1 REMOVED FROM P. M. ACTIVITIES TO SUPPORT CONTINGENCY RELATED WORK. IMBLMS-SAME AS FOR A MCC-SAME AS FOR A	CREW-NONE IN P. M. ALL SUPPORT CONTINGENCY RELATED WORK. IMBLMS-NOTHING MCC-NO P. M. RELATED FUNCTIONS, EXCEPT FOLLOW-UP ADVICE. SUPPORTS PERFORMANCE OF CONTINGENCY TASKS.
III. INFORMATION FLOW: a) INFORMATION REQUIRED b) ACTIVE LINKS c) DATA PRODUCED 1) FILM (TYPE #FRAMES OR FEET, WEIGHT TO BE RET'D QUARTERLY, ETC.) 2) TAPE (BIT RATES-MAXIMUM SUSTAINED, PEAK, AVG.; SPECIAL DUMP REQ'S.) 3) REAL TIME TRANSMISSION	a) EEG & EKG &, PERHAPS, EMG ON SLEEPING MEN b) OWS-MCC, FOR OCCASIONAL TELEMETRY & VOICE COMMUNICATION c) TAPE RECORD 3-4 TIMES PER HOUR FOR 2 MINUTES (1 MIN. EACH SLEEPING MAN, SUCCESSIVELY) AT ≤ 20 KBPS. MAY SUFFICE TO MONITOR EKG & JUST RECORD ANOMALIES.	a) SAME AS FOR A. ALSO, GENERAL STATUS OF MEN IN R & R, i.e. ARE THEY WELL RESTED & HOW AVAILABLE ARE THEY FOR WORK? b) SAME AS FOR A c) SAME AS FOR A	a) SAME AS FOR A b) SAME AS FOR A c) SAME AS FOR A	a) SAME AS FOR A. ALSO, SICK MAN STATUS. b) SAME AS FOR A. c) SAME AS FOR A, EXCEPT RECORD PERIODS COULD LAST 3 MINUTES INSTEAD OF 2. SICK MAN DATA COULD BE SENT OCCASIONALLY IN REAL TIME.	a) SAME AS FOR B. ALSO, SICK MAN STATUS. b) SAME AS FOR A c) SAME AS FOR D	a) SAME AS FOR D b) SAME AS FOR A c) SAME AS FOR A PLUS MEDICAL ASSESSMENT DATA (LOW BIT RATE)	a) SAME AS FOR E b) SAME AS FOR A c) SAME AS FOR F	a) SAME AS FOR A. ALSO, NATURE OF PROBLEM & STATUS OF MEN IN P. M. ACTIVITIES, I. E., ORDER OF AVAILABILITY. b) SAME AS FOR A c) SAME AS FOR A PLUS PROBLEM ASSESSMENT DATA (VOICE: ~ 30 KBPS)	a) PROBLEM STATUS & IMPACT ON CREW. b) SAME AS FOR A c) PROBLEM & CREW STATUS ASSESSMENT DATA (VOICE: ~ 30 KBPS)
IV. RESOURCES REQUIRED: a) POWER b) OTHER (BESIDES ORDINARY CONSUMABLES, LIKE FOOD, WATER, & O_2)	a) 75 WATTS FOR IMBLMS MEASUREMENTS (NOT INCL. STAND-BY POWER OF 125 W ACCOUNTED FOR IN BIOMED. SUBSEQ.) + UP TO 500 WATTS FOR SHOWER ≤ 575 WATTS TOTAL b) PERSONAL HYGIENE MATERIALS	a) 75 WATTS FOR IMBLMS, AS FOR A, AND UP TO 300 WATTS FOR RADIO, TV, OR MICROFILM IN R & R≤ 375 WATTS TOTAL b) NONE	a) 75 WATTS FOR IMBLMS, AS FOR A, AND UP TO ABOUT 200 WATTS FOR WARM WASH WATER ≤ 275 WATTS TOTAL. b) SAME AS FOR A	a) UP TO 575 WATTS AS PER A + UP TO 300 WATTS FOR ENTERTAINMENT OF SICK MAN ≤ TOTAL OF 875 WATTS. b) SAME AS FOR A + KEY MEDICINAL AGENTS, SUCH AS ASPIRIN, ANTIBIOTICS, ETC.	a) ≤ 375 WATTS AS PER B b) SAME AS FOR D	a) SAME AS FOR A (ENTERTAINMENT AS PER D IS NOT LIKELY DURING ATTENDANCE PERIODS) b) SAME AS FOR D	a) 75 WATTS FOR IMBLMS (ENTERTAINMENT NOT LIKELY IN THIS MODE) b) SAME AS FOR D	a) ≤ 575 WATTS, AS FOR A b) SAME AS FOR A	a) NONE FOR P. M. b) NONE
V. TRANSITIONS: a) SCHEDULED (NOMINAL) b) UNSCHEDULED (CONTINGENCIES & OTHER)	a) AT $t = t_0 + 2, +10,$ & $+18$ – GO TO B b) 1. IF 1 OF THE 2 CREWMEN NOT ENGAGED IN P. M. BECOMES UNAVAILABLE FOR WORK, DUE TO ILLNESS, DECONDITIONING, ETC., – GO TO D OR F, AS APPROPRIATE. 2. IF EXCESSIVE WORK REQUIREMENT OCCURS WHICH CAN'T BE HANDLED EITHER WITHIN MODE OR BY POSTPONEMENT TO MORE CONVENIENT TIME – GO TO H OR I, AS APPROPRIATE.	a) AT $t = t_0 + 6, +14,$ & $+22$ – GO TO C. b) 1. IF 1 OF THE 4 CREWMEN NOT IN P. M. BECOMES UNAVAILABLE (AS IN A) - GO TO E OR G, AS APPROPRIATE. 2. SAME AS FOR A	a) AT $t = t_0 + 8, +16,$ & $+24$ – GO TO A b) 1. NOT APPLICABLE (ALL CREWMEN ARE IN P. M.) 2. SAME AS FOR A 3. IF MAN SCHEDULED FOR WORK IN FOLLOWING MODE GETS SICK, AT NOM. TRANSITION TIME – GO TO D OR F, AS APPROPRIATE	a) 1. ON RECOVERY–RETURN TO A 2. IF NOT RECOVERED BY NOMINAL TRANSITION TIME – GO TO E. b) 1. IF SICK MAN REQUIRES ASSISTANCE–GO TO F. 2. SAME AS FOR A	a) 1. ON RECOVERY–RETURN TO B 2. IF NOT RECOVERED BY NOMINAL TRANSITION TIME–GO TO C. b) 1. IF SICK MAN REQUIRES ASSISTANCE–GO TO G. 2. SAME AS FOR A	a) 1. ON IMPROVEMENT OR OTHER RELAXATION OF REQUIREMENT FOR ASSISTANCE–GO TO D. 2. IF ASSISTANCE STILL NEEDED AT NOM. TRANS. TIME–GO TO G. b) 1. IF CONDITION WORSENS–CONSULT MCC RE TRANSFER TO ABORT MODE (OPERS. & MAINT. SUBSEQ.) & GO IF NECESSARY. 2. SAME AS FOR A	a) 1. SAME AS FOR F, EXCEPT GO TO E (NOT D) 2. IF ASSISTANCE STILL NEEDED AT NOM. TRANS. TIME–GO TO C b) 1. SAME AS FOR F 2. SAME AS FOR A	a) ON COMPLETION OF EXCESSIVE WORK LOAD–GO TO A, B, ... G, AS APPROPRIATE. b) IF WORK LOAD EXCESS DOES NOT DIMINISH AFTER LOSS OF 4 HRS SLEEP, CONSULT MCC RE OPTIONS, SOME OF WHICH ARE– 1) REDUCE OTHER TASKS & RETURN TO NOMINAL MODE, 2) ALTERNATE SLEEPING MEN UP TO 4 MORE HRS, 3) GO TO I.	a) IF NORMAL OPERATIONS ARE RESTORED–GO TO A, B, ... G, AS APPROPRIATE. b) IF CONTINGENCY CAN'T BE RESOLVED WITHIN ALLOWED TIME–ABORT.

FIGURE 2 - PERSONAL MAINTENANCE SUBSEQUENCE